ALCOHOLISM CLINICAL & EXPERIMENTAL RESEARCH

Prenatal Alcohol Consumption Between Conception and Recognition of Pregnancy

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Background: Current estimates of the rates of alcohol-exposed pregnancies may underestimate prenatal alcohol exposure if alcohol consumption in early trimester 1, prior to awareness of pregnancy, is not considered. Extant literature describes predictors of alcohol consumption during pregnancy; however, alcohol consumption prior to awareness of pregnancy is a distinct behavior from consumption after becoming aware of pregnancy and thus may be associated with different predictors. The purpose of this study was therefore to examine prevalence and predictors of alcohol consumption by women prior to awareness of their pregnancy, and trajectories of change to alcohol use following pregnancy recognition.

Methods: Pregnant women (n = 1,403) were prospectively recruited from general antenatal clinics of 4 public hospitals in Australian metropolitan areas between 2008 and 2013. Women completed detailed interviews about alcohol use before and after recognition of pregnancy.

Results: Most women (n = 850, 60.6%) drank alcohol between conception and pregnancy recognition. Binge and heavy drinking were more prevalent than low-level drinking. The proportion of women who drank alcohol reduced to 18.3% (n = 257) after recognition of pregnancy. Of women who drank alcohol, 70.5% ceased drinking, 18.3% reduced consumption, and 11.1% made no reduction following awareness of pregnancy. Socioeconomic status (SES) was the strongest predictor of alcohol use, with drinkers more likely to be of high rather than low SES compared with abstainers (OR = 3.30, $p < 0.001$). Factors associated with different trajectories (either cessation, reduction, or continuation of drinking) included level of alcohol use prior to pregnancy recognition, age, pregnancy planning, and illicit substance use.

Conclusions: In this sample of relatively high SES women, most women ceased or reduced drinking once aware of their pregnancy. However, the rate of alcohol-exposed pregnancies was higher than previous estimates when the period prior to pregnancy recognition was taken into account.

Key Words: Alcohol, Pregnancy, Epidemiology, Public Health, Obstetrics.

PRENATAL ALCOHOL EXPOSURE (PAE) is associated with a range of physical, neuropsychological, and behavioral deficits of varying severity that may result from PAE, grouped under the umbrella term fetal alcohol spectrum disorders (FASD). The best available evidence currently does not suggest observable adverse outcomes are associated with low-level PAE (Flak et al., 2014), yet significant methodological limitations inherent with observational studies make this difficult to ascertain. Because a "safe" level of alcohol consumption has not been established, current public health guidelines in Australia advise abstinence from alcohol as the safest approach for women who are pregnant or planning a pregnancy (National Health and Medical Research Council, 2009), consistent with guidelines in place in most other Organisation for Economic Co-operation and Development countries. Despite this, a significant number of women continue to consume alcohol while pregnant. The Center for Disease Control recently released a report highlighting the significant prevalence of pregnancies in the United States considered to be "at risk" of alcohol exposure, with 7.3% of sexually active, nonpregnant, and nonsterile women drinking alcohol without using effective contraception, irrespective of pregnancy desire (Green, 2016). Alcohol

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use by pregnant women is not prohibited or punishable by any law in any Australian jurisdiction.

Substance use in any society is dependent on a range of individual and cultural factors, and alcohol use behavior by pregnant women may be driven by similar influences that result in unhealthy or risky use of alcohol in the general population (Room, 2013). Alcohol consumption during pregnancy partially reflects attitudes toward alcohol in Australian society, where consumption is socially acceptable and highly prevalent. Data from the 2013 National Drug Strategy Household Survey showed that 80% of Australians aged 14 and over consumed alcohol, and 18.2% of all Australians consumed an average of more than 2 standard drinks per day, which exceeds current health risk guidelines. Risk-taking related to alcohol use was also common, with approximately 20% of drinkers reporting instances in the previous 12 months in which they had put themselves or others at risk of harm while under the influence of alcohol (AIHW, 2014). The continuation of alcohol use into pregnancy in Australia may be partly attributable to Australian drinking culture and should be considered within this context.

Estimates of rates of alcohol-exposed pregnancies in Australia range from 37% (Giglia and Binns, 2007; Hutchinson et al., 2013) to 72% (Anderson et al., 2012), varying significantly according to sampling methods and definitions of alcohol use. It is often unclear, however, whether alcohol consumption prior to pregnancy recognition has been taken into account in such estimates. The studies that have compared rates of alcohol consumption prior to conception with consumption during pregnancy, surmise that this rate of consumption continues until the point of pregnancy recognition in many women (Anderson et al., 2014; Mallard et al., 2013; Nilsen et al., 2008), a not unreasonable conclusion. However, there is currently limited published data concerning women's actual alcohol consumption in the early period of pregnancy between conception and recognition. Authors speculate that asking women simply to report their alcohol use "during pregnancy" may inadvertently prompt women to only report alcohol they consumed once becoming aware of their pregnancy, unless alcohol use in the time period between conception and pregnancy recognition was specifically queried. It is possible that true rates of alcohol-exposed pregnancies may in fact be even higher than previously thought when this early period prior to pregnancy recognition is taken into account.

One of the earliest studies to explore this issue was the Seattle Longitudinal Study, which found a higher incidence of binge drinking in the early period of pregnancy prior to pregnancy recognition in a sample recruited in 1974—a time prior to widespread awareness and guidelines regarding the risks associated with heavy PAE (Streissguth et al., 1990). Another early cohort study assessed alcohol use by women across pregnancy, including separate measures for each month of the first trimester. Alcohol use was highest in the first and second months of pregnancy, with both the proportion of women who drank and the quantity of alcohol consumed by drinkers being substantially lower in the third month of trimester 1 and in the second and third trimesters (Day et al., 1989).

One cohort study specifically retrospectively inquired about alcohol use "around the time of conception" and reported a reduction in the amount of alcohol consumed by women between conception and later in pregnancy (Jacobson et al., 2002), yet factors associated with alcohol use or trajectories of change to alcohol use were not examined.

Epidemiological studies in Australia (Anderson et al., 2013; Giglia and Binns, 2007; Hutchinson et al., 2013; Kingsbury et al., 2015) and North America (Meschke et al., 2008) have reported women who consume alcohol during pregnancy tend to be older, more highly educated, and earn higher incomes, than those who do not. Longer history of alcohol consumption, higher education, temptation to drink alcohol, and more confidence to manage social situations predicted heavier drinking among pregnant women screened positive for alcohol use problems (Chang et al., 2005). Again, however, these descriptions relate to alcohol consumption following pregnancy awareness. Choosing to drink alcohol once pregnancy is recognized is conceptually a different behavior to drinking alcohol without awareness of pregnancy and thus may be associated with a different set of predictors. Because an estimated 47% of pregnancies in Australia are unintended (Colvin et al., 2007), many women may inadvertently expose the fetus to alcohol before becoming aware of the pregnancy. As such, factors associated with alcohol use prior to pregnancy recognition may be more similar to those that predict alcohol use in nonpregnant women; however, this is not expected to be uniform due in part to differences in pregnancy wantedness (i.e., actively planning, ambivalent toward, or avoidant of pregnancy), which may influence drinking behavior. In this case, the period of pregnancy between conception and pregnancy recognition is a unique period that warrants focused study.

A large North American study indicated that factors correlated with risk for alcohol-exposed pregnancy (defined as being a woman who drinks alcohol, is sexually active, and not using effective contraceptive methods) included history of tobacco and illicit drug use, history of hospitalization for mental health or substance use, history of physical abuse, and having multiple sexual partners (Project CHOICES Research Group, 2002). The U.S. Center for Disease Control report risk for alcohol-exposed pregnancy being highest among women who are married or cohabiting with partners; current smokers; in their second pregnancy; aged between 25 and 29 years; and that risk was positively associated with education (Green, 2016). However, actual alcohol use during pregnancy was not measured in these studies.

It would also be beneficial to understand what factors predict whether women will cease, reduce, or continue drinking alcohol once becoming aware of their pregnancy. There is a paucity of research exploring factors associated with this decision at the point of pregnancy recognition, but some emerging evidence comes from studies comparing alcohol

consumption in the months leading up to conception to consumption later in pregnancy. Level of alcohol use prior to pregnancy is one predictor of the trajectory of alcohol use following pregnancy recognition, with women reporting binge or heavy drinking prior to pregnancy being likely to also report drinking during pregnancy (Anderson et al., 2014; Ethen et al., 2009; Mallard et al., 2013). An American population-based study reported that older age, higher education, experiencing abuse during pregnancy, being homeless, and having close friends or family with substance use problems predicted increased likelihood to reduce rather than quit alcohol use from prepregnancy to third trimester (Kitsantas et al., 2014). Harrison and Sidebottom (2009) reported that older age, current smoking, and lack of transportation predicted continuation of alcohol use into pregnancy. A Swedish study also implicated older age as a risk factor for continuation of drinking into pregnancy, as well as being a heavier drinker and having a greater number of previous births (Nilsen et al., 2008). One of the few studies to specifically address alcohol use between conception and pregnancy recognition found that, in township women in Cape Town, South Africa, drinking prior to pregnancy recognition was associated with being younger, single, having better living conditions, tobacco use, a greater number of sexual partners, and higher incidence of having experienced intimate partner violence (O'Connor et al., 2011).

The purpose of this study was to specifically examine change in alcohol consumption from the first trimester (T1) prior to pregnancy recognition, to alcohol consumption immediately following pregnancy recognition. Specifically, the 2 aims of this study were to:

1. Identify factors associated with alcohol use in the period between conception and pregnancy recognition, and
2. Describe patterns of change to alcohol use following pregnancy recognition and factors predicting whether women will cease, reduce, or continue alcohol consumption.

MATERIALS AND METHODS

Participants

Data were drawn from a prospective pregnancy cohort study, The Triple B Pregnancy Cohort Study (Bumps, Babies and Beyond), carried out by investigators from the University of New South Wales and Curtin University. The study sought to examine impacts of a range of factors, including substance use, on infant development, and family functioning. Pregnant women were recruited between 2008 and 2013 from general antenatal clinics at metropolitan public hospitals in New South Wales and Western Australia. Ethical approval was granted by human research ethics committees at all hospitals, and accordingly, all data remained confidential within the study team. Interviewers possessed, at a minimum, a Bachelor degree in psychology or related discipline, including training in research methods and design and ethical research conduct. Interviewers were trained by Doctorate-level principal investigators, and random selection of interviews was recorded and checked by senior research officers for adherence to protocol, quality, and consistency of data recording.

Eligibility criteria included: being pregnant; being at least 16 years of age; having no major known medical complications (mother or fetus); intention of mother or both parents to be the primary caregiver/s; intention to reside in Australia for at least the child's first year; and possessing sufficient literacy in English to complete interviews and questionnaires. Women were provided with detailed study information, and informed consent was obtained from women at the point of recruitment. Recruitment and participation rates are shown in Fig. 1.

The present analyses included 1,404 women from the Triple B sample from NSW and WA, for whom alcohol use data both pre- and postrecognition of their pregnancy were available. This separate measure of alcohol use prior to pregnancy recognition was introduced after data collection had already commenced, so was not available for 227 women.

Data were collected via telephone interview. Familiarity in contact with researchers was recognized as being important in establishing rapport, so each participant was contacted and interviewed by 1 consistent member of the research team. If this was impossible due to scheduling or staff disruptions, participants were referred to another experienced researcher.

Measures

Alcohol Use. Maternal prenatal alcohol consumption was assessed at interviews conducted during the first trimester (beginning of pregnancy to 13th week; T1) and trimester 2 (T2; 14th week to 25th week of pregnancy). Alcohol consumption during T1 was recorded separately pre- and postawareness of pregnancy. Participants were asked to indicate typical frequency of alcohol use during each time period ("everyday," "5 to 6 times a week," "3 to 4 times a week," "1 to 2 times a week," "2 to 3 times a month," "once a month," "once or twice during the period"); and specific type and quantity of alcohol consumed on these occasions, which was subsequently converted into standard drinks (1 standard drink = 10 g alcohol) by researchers. Quantity and frequency of alcohol consumed on their heaviest drinking occasion during each time period was also recorded.

Participants were categorized into 5 different levels of alcohol consumption for each time period using a composite method, taking into account the timing, frequency, and quantity of consumption(O'Leary et al., 2010). These categories were "abstinent" (no consumption), "low" (≤7 standard drinks per week, up to 2 standard drinks per occasion), "moderate" (≤7 standard drinks per week, >2 to ≤4 standard drinks per occasion), "binge" (≤7 standard drinks per week, >4 standard drinks per occasion), and "heavy" (>7 standard drinks per week; with a frequency of at least weekly or more often). The definition of "binge" was altered slightly from O'Leary and colleagues' (2010) definition so as to be more consistent with the most recent Australian National Health and Medical Research Council (NHMRC) guidelines around risky drinking, referring to heavy episodic drinking.

Change in Alcohol Use Following Pregnancy Awareness. Participants' alcohol use was categorized using the above method separately for consumption prior to awareness of pregnancy and consumption after awareness of pregnancy. Participants who remained in the same alcohol use category pre- and postawareness of pregnancy, or who were in a higher alcohol use category after pregnancy awareness, were classified as "no reduction." Participants who were drinking alcohol prior to pregnancy awareness and continued to drink after becoming aware of their pregnancy, but at a lower level, were classified as "reduction." Participants who drank alcohol prior to pregnancy awareness but were then in the abstinent alcohol use category after pregnancy awareness were classified as "cessation."

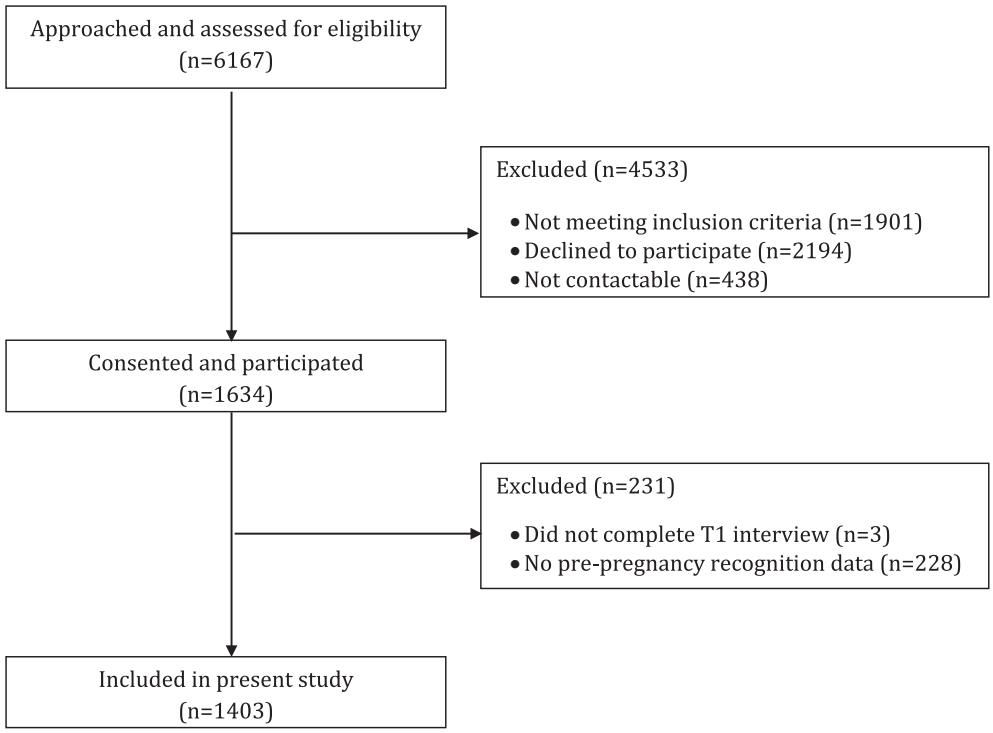

Fig. 1. Recruitment and participation rates.

Participants who were abstinent both pre- and postpregnancy awareness were considered "abstinent throughout."

Maternal Characteristics

Maternal age, parity, height, weight, education, residential information, country of birth, tobacco and illicit substance use, and pregnancy planning was obtained via interviews during the third trimester of pregnancy.

Socioeconomic Status. The Index of Relative Socio-Economic Advantage and Disadvantage from the Socio-Economic Indexes for Areas (SEIFA) data package from the Australian Bureau of Statistics was used to classify participants into low, moderate, or high socioeconomic status (SES) categories based on their residential postcode at the time of recruitment (Australian Bureau of Statistics, 2011). This index summarizes information about economic and social conditions of people and households within an area. The distribution of SEIFA scores is divided into 10 equal deciles. Here, participants falling into deciles 1 to 3 were classified as "low" SES, deciles 4 to 7 were classified as "moderate," and deciles 8 to 10 were classified as "high" SES.

Parity. Parity was defined as the total number of pregnancies carried to term prior to the current pregnancy, including stillbirths (Creinin and Simhan, 2009).

Tobacco and Illicit Substance Use. At the T1 interview, participants were asked "Did you use tobacco between the time of conception until awareness of pregnancy?" Participants who answered "yes" were coded as having used tobacco in T1 prior to awareness of pregnancy. This question was repeated, with separate questions referring to cannabis, heroin, cocaine, amphetamines, hallucinogens, club drugs, nonprescribed benzodiazepines, nonprescribed opioids, nonprescribed antidepressants, and inhalants. Participants who answered "yes" to any of these were coded as having used an illicit substance in T1 prior to pregnancy awareness.

Pregnancy Planning. At the baseline interview, participants were asked: "Now thinking back to just before you got pregnant with this baby, how did you feel about becoming pregnant?" Response options were (i) "I wanted to become pregnant"; (ii) "I didn't want to become pregnant"; (iii) "I hadn't thought about becoming pregnant"; or (d) "other." Participants whose response was (i) were considered to have planned their pregnancies. Participants whose response was either (ii) or (iii) were considered to have not actively planned their current pregnancies. Participants whose response was "other" (n = 69) were asked for more information by researchers, and these open-ended responses were individually examined to determine whether they suggested the pregnancy was actively planned or not. Some possible inconsistencies between reported pregnancy planning and contraceptive use were noted—specifically, of the 1,007 women whose pregnancies were planned, 33 reported using some form of contraception at the time they became pregnant (data not shown). However, it was not possible to distinguish between use of contraception with different partners, so it is possible that some women may have used contraception with sexual partners other than the father of their child.

Statistical Analyses

Analyses were planned a priori independent of the data and conducted using IBM SPSS Statistics for Windows version 22 (IBM Corp, 2013). Women in either the low, moderate, binge, or heavy alcohol use categories in T1 prior to pregnancy awareness were classified as "drinkers," and frequencies of maternal characteristics were compared to those in the abstinent category. A series of planned logistic regressions were performed to obtain unadjusted odds ratios comparing maternal characteristics of drinkers and abstainers. All dependent variables were then

included in a further logistic regression to obtain adjusted odds ratios. Participants with missing data on independent variables were excluded via listwise deletion.

It was further decided to conduct post hoc sensitivity analyses to determine whether different sets of maternal characteristics were associated with low-moderate level drinking compared with binge or heavy drinking, given the significant variation in the amount of alcohol consumed by women classified broadly as "drinkers." Women in low and moderate alcohol use categories were therefore grouped together and compared with women in the binge or heavy alcohol use categories using adjusted and unadjusted logistic regressions.

To determine predictors of change to alcohol use following pregnancy awareness among drinkers, multinomial logistic regression was performed comparing maternal characteristics of participants whose change in alcohol use was classified as "reduction," "no reduction," or "cessation." Independent variables were household SES, age, parity, prepregnancy body mass index (BMI), level of education, marital status, tobacco use, and illicit substance use prior to awareness of pregnancy, pregnancy planning, and the level of alcohol use prior to pregnancy awareness.

RESULTS

Prevalence of Alcohol Use Before and After Pregnancy Recognition

Patterns of alcohol use pre- to postpregnancy recognition are cross-tabulated in Table 1. Most women ($n = 850$, 60.6%) drank alcohol between conception and pregnancy recognition. Binge and heavy drinking were more prevalent than low-level drinking. The proportion of women who drank alcohol reduced to 18.3% ($n = 257$) after recognition of pregnancy. Of women who drank alcohol, 70.5% ceased drinking, 18.3% reduced consumption, and 11.1% made no reduction following awareness of pregnancy. Alcohol use remained low for the remainder of pregnancy, with 70.7% of women abstaining in T2 and 71% abstaining in T3.

Predictors of Change in Alcohol Consumption Following Pregnancy Awareness

A multinomial logistic regression analysis was conducted as planned a priori (see Table 2). The overall model likelihood ratio was significant, $\chi^2(46) = 334.741$, $p < 0.001$, with moderate fit (Nagelkerke pseudo R-square = 0.423). The overall model summary showed level of alcohol use prior to pregnancy awareness, $\chi^2(8) = 249.322$, $p < 0.001$, had the strongest association with change in alcohol use following awareness of pregnancy, followed by pregnancy planning, $\chi^2(2) = 10.119$, $p = 0.006$, illicit substance use, $\chi^2(2) = 11.770$, $p = 0.003$, and BMI category, $\chi^2(6) = 12.809$, $p = 0.046$.

Reduction Versus Cessation. Relative to women who ceased drinking following pregnancy awareness, women who only reduced drinking were less likely to be 24 years or younger than they were to be 36 years or older; were less likely to have only completed some school than they were to have completed a bachelor degree or higher; were more likely to have planned their pregnancy than to have an unplanned pregnancy; more likely to have used illicit substances in T1; and were more likely to be heavy rather than moderate drinkers.

No Reduction Versus Cessation. Women who continued to drink alcohol at the same level following pregnancy recognition were less likely to be aged 30 to 35 than they were to be 36 years or older; were more likely to be underweight or normal weight than they were to be obese; more likely to have unplanned pregnancies; and were more likely to be in the low alcohol use category than the heavy category, relative to people who ceased drinking. Women who ceased drinking completely were less likely to use illicit substances than those who continued drinking alcohol at the same level (Table 2).

Reduction Versus No Reduction. Women who reduced alcohol consumption following pregnancy recognition were more likely to be aged 30 to 35 rather than 36 years or older, more likely to be in their first pregnancy than to have had 3 or more previous pregnancies, and were more likely to be in the moderate rather than heavy alcohol use category prior to pregnancy recognition, relative to women who continued drinking at the same level after pregnancy recognition (Table 2).

Predictors of Alcohol Use Prior to Pregnancy Awareness

Planned univariate analyses compared those who consumed any amount of alcohol prior to awareness of pregnancy, to those who abstained. Test of overall effects showed drinkers and abstainers were found to differ on the majority of maternal characteristics and demographic factors that

Table 1. Frequencies in Alcohol Use Categories Pre- and Postpregnancy Awareness

n Alcohol use prepregnancy awareness	*n* Alcohol use postpregnancy awareness (%)					
	Abstinent	Low	Moderate	Binge	Heavy	Total
Abstinent	531 (96.0)	17 (3.1)	4 (0.7)	1 (0.2)	0	553 (39.4)
Low	204 (80.0)	50 (19.6)	0	1 (0.4)	0	255 (18.2)
Moderate	83 (77.6)	15 (14.0)	7 (6.5)	2 (1.9)	0	107 (7.6)
Binge	159 (73.3)	45 (20.7)	9 (4.1)	3 (1.4)	1 (0.5)	217 (15.5)
Heavy	169 (62.4)	72 (26.6)	12 (4.4)	7 (2.6)	11 (4.1)	271 (19.3)
Total	1,146 (81.7)	199 (14.2)	32 (2.3)	14 (1.0)	12 (0.9)	1,403

Table 2. Maternal Factors Predicting Alcohol Use Change from Pre- to Postpregnancy Awareness

	Reduction versus cessation OR (95% CI)	No reduction versus cessation OR (95% CI)	Reduction versus no reduction OR (95% CI)
Household socioeconomic status			
Low	1.921 (0.522 to 7.075)	0.350 (0.035 to 3.506)	5.482 (0.405 to 74.282)
Moderate	0.900 (0.555 to 1.458)	1.236 (0.671 to 2.275)	0.728 (0.344 to 1.539)
High	1	1	1
Maternal age			
≤24	0.337 (0.118 to 0.964)*	0.552 (0.158 to 1.931)	0.612 (0.130 to 2.885)
25 to 29	0.887 (0.480 to 1.640)	0.606 (0.263 to 1.396)*	1.464 (0.541 to 3.962)
30 to 35	1.237 (0.762 to 2.008)	0.531 (0.276 to 1.021)*	2.332 (1.066 to 5.100)*
≥36	1	1	1
Parity—*N* (%)			
0	2.828 (0.589 to 13.583)	0.387 (0.113 to 1.323)	7.307 (1.072 to 49.802)*
1 to 2	3.258 (0.684 to 15.527)	0.668 (0.204 to 2.189)	4.876 (0.739 to 32.178)
3+	1	1	1
Prepregnancy BMI			
Underweight	1.669 (0.609 to 4.574)	5.146 (1.158 to 22.865)*	0.324 (0.058 to 1.820)
Normal weight	1.633 (0.846 to 3.150)	4.233 (1.372 to 13.059)*	0.386 (0.108 to 1.382)
Overweight	1.248 (0.580 to 2.683)	1.935 (0.509 to 7.352)	0.645 (0.143 to 2.906)
Obese	1	1	1
Education			
Some school	0.374 (0.153 to 0.917)*	0.631 (0.158 to 2.530)	0.593 (0.122 to 2.874)
Year 12	0.681 (0.360 to 1.289)	1.079 (0.453 to 2.570)	0.631 (0.226 to 1.761)
Certificate/Diploma	0.641 (0.338 to 1.213)	0.412 (0.145 to 1.172)	1.555 (0.474 to 5.108)
Bachelor or higher	1	1	1
Marital status			
Not married	0.972 (0.625 to 1.512)	0.982 (0.517 to 1.866)	0.989 (0.467 to 2.094)
Married	1	1	1
Country of birth			
Australia	1.441 (0.788 to 2.636)	1.568 (0.781 to 3.148)	0.919 (0.376 to 2.249)
Other English-speaking	1.784 (0.931 to 3.420)	1.213 (0.503 to 2.925)	1.470 (0.511 to 4.230)
Other	1	1	1
Tobacco use			
No	0.797 (0.472 to 1.347)	0.797 (0.335 to 1.895)	1.01 (0.381 to 2.625)
Yes	1	1	1
Illicit substance use			
No	0.384 (0.195 to 0.756)**	0.273 (0.098 to 0.764)*	1.404 (0.453 to 4.349)
Yes	1	1	1
Pregnancy planning			
Not planned	1.668 (1.041 to 2.675)*	2.307 (1.226 to 4.341)**	0.723 (0.341 to 1.535)
Planned	1	1	1
Alcohol use pre-awareness			
Low	N/A	5.463 (2.410 to 12.382)***	N/A
Moderate	0.406 (0.214 to 0.768)**	2.535 (0.929 to 6.918)	0.160 (0.052 to 0.489)***
Binge	0.707 (0.458 to 1.092)	0.618 (0.183 to 2.090)	1.144 (0.328 to 3.987)
Heavy	1	1	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

were examined (Table 3). Examination of frequencies showed, in summary, that drinkers were from higher SES backgrounds, were more likely to be in their first pregnancy, were less likely to be overweight or obese, less likely to be married, more likely to have been born in Australia or another primarily English-speaking country, have higher educational attainment, were more likely to also smoke and use illicit substances, and their pregnancies were less likely to be planned.

A logistic regression was performed to determine which maternal characteristics were most strongly associated with drinking in T1 prior to pregnancy awareness after adjustment for other maternal factors (Table 3). SES had the strongest association with drinking prior to pregnancy awareness, with drinkers less likely to be of low or moderate than high SES, relative to abstainers. Drinkers were more likely to be in their first pregnancy than to have had 3 or more previous pregnancies; less likely to have completed only some high school than to have completed a university degree; were more likely to have been born in Australia or another primarily English-speaking country than to have been born in a non-English-speaking country, and were more likely to be smokers, relative to abstainers. Drinkers pregnancies were more likely to be unplanned than abstainers (see Table 3).

Sensitivity Analyses—Level of Alcohol Use Prior to Pregnancy Awareness

Sensitivity analyses were carried out to assess whether different levels of alcohol consumption prior to pregnancy

Table 3. Demographic and Maternal Characteristics of Drinkers and Abstainers Prior to Pregnancy Awareness

Maternal characteristics	Abstainers *n* (%)	Drinkers *n* (%)	Drinkers versus abstainers – unadjusted OR (95% CI)	Drinkers versus abstainers – adjusted OR[a](95% CI)
Household socioeconomic status				
Low	46 (8.5)	27 (3.3)	0.292 (0.178 to 0.480)***	0.330 (0.185 to 0.588)***
Moderate	208 (38.2)	221 (26.6)	0.529 (0.418 to 0.670)***	0.609 (0.470 to 0.791)***
High	290 (53.3)	582 (70.1)	1	1
Aboriginal or Torres Strait Islander Origin Islander				
No	507 (95.7)	801 (97.2)	1.429 (0.761 to 2.685)	1.586 (0.768 to 3.274)
Yes	19 (3.6)	21 (2.5)	1	1
Maternal age				
≤24	60 (10.9)	69 (8.2)	0.729 (0.486 to 1.093)	0.677 (0.401 to 1.142)
25 to 29	131 (23.8)	178 (21.1)	0.861 (0.633 to 1.173)	0.856 (0.600 to 1.222)
30 to 35	218 (39.6)	374 (44.3)	1.088 (0.831 to 1.423)	1.134 (0.841 to 1.529)
≥36	142 (25.8)	224 (26.5)	1	1
Parity—N (%)				
0	258 (48.9)	481 (59.3)	1.751 (1.048 to 2.925)*	0.826 (0.473 to 1.439)*
1 to 2	239 (45.3)	297 (36.6)	1.167 (0.695 to 1.962)	1.387 (0.765 to 2.516)
3+	31 (5.9)	33 (4.1)	1	1
Prepregnancy BMI				
Underweight	42 (8.2)	46 (5.7)	0.843 (0.510 to 1.395)	0.826 (0.473 to 1.439)
Normal weight	283 (55.5)	512 (63.6)	1.393 (1.017 to 1.909)*	1.386 (0.978 to 1.964)
Overweight	98 (19.2)	134 (16.6)	1.053 (0.718 to 1.543)	1.013 (0.671 to 1.528)
Obese	87 (17.1)	113 (14.0)	1	1
Level of education				
Some school	67 (12.7)	62 (7.6)	0.569 (0.392 to 0.826)**	0.500 (0.301 to 0.829)**
Year 12	57 (10.8)	109 (13.4)	1.177 (0.830 to 1.668)	1.085 (0.723 to 1.629)
Certificate/Diploma	82 (15.5)	116 (14.3)	0.870 (0.635 to 1.192)	0.800 (0.558 to 1.147)
Bachelor or higher	323 (61.1)	525 (64.7)	1	1
Marital status				
Not married	173 (32.8)	354 (67.2)	1.323 (1.051 to 1.665)*	1.106 (0.839 to 1.460)
Married	318 (39.3)	492 (60.7)	1	1
Country of birth				
Australia	292 (55.1)	480 (58.3)	1.745 (1.347 to 2.260)***	1.874 (1.400 to 2.510)***
Other English-speaking	65 (12.3)	181 (22.0)	2.955 (2.072 to 4.215)***	3.020 (2.061 to 4.424)***
Other	173 (32.6)	163 (19.8)	1	1
Tobacco use				
No	476 (87.5)	68 (12.5)	0.527 (0.389 to 0.714) ***	0.446 (0.298 to 0.667)***
Yes	653 (78.7)	177 (21.3)	1	1
Illicit use				
No	516 (94.9)	756 (91.1)	0.554 (0.354 to 0.869)**	0.807 (0.467 to 1.395)
Yes	28 (5.1)	74 (8.9)	1	1
Pregnancy planning				
Unplanned	113 (21.4)	216 (26.6)	1.331 (1.027 to 1.726)*	1.553 (1.141 to 2.114)**
Planned	415 (78.6)	596 (73.4)	1	1

[a]Adjusted for all other maternal characteristics.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

awareness were associated with different predictors. Specifically, women who drank at heavy or binge levels were separately compared to abstainers. Unadjusted analyses showed differences in SES, parity, education level, marital status, country of birth, tobacco use, illicit substance use, and pregnancy planning between groups. Adjusted logistic regression found that, relative to abstainers, binge/heavy drinkers were less likely to be of low (OR = 0.476, 95% CI: 0.241 to 0.940, $p = 0.033$), or moderate (OR = 0.620, 95% CI: 0.452 to 0.851, $p = 0.003$), than high SES; were less likely to be aged 24 years or under than 36 years old or over (OR = 0.366, 95% CI: 0.194 to 0.690, $p = 0.002$); were more likely to be in their first pregnancy than to have 3 or more previous pregnancies (OR = 3.484, 95% CI: 1.618 to 7.501, $p = 0.001$); were less likely to have only completed some high school than they were to have completed a bachelor degree or higher (OR = 0.548, 95% CI: 0.305 to 0.983, $p = 0.044$), were more likely to have been born in Australia (OR = 2.406, 95% CI 1.655 to 3.498, $p < 0.001$), or another English-speaking country (OR = 4.657, 95% CI 2.955 to 7.338, $p < 0.001$) than to have been born in a non-English-speaking country; were more likely to have smoked (OR = 3.329, 95% CI: 2.209 to 5.518, $p < 0.001$); and were more likely to have an unplanned pregnancy (OR = 1.796, 95% CI: 1.254 to 2.572, $p < 0.001$). This pattern of predictors is similar to that reported in the previous section for alcohol use in general, suggesting that binge and heavy drinking was not associated with a unique set of predictors.

DISCUSSION

Alcohol use during the period between conception and pregnancy recognition was high in this sample, with 60% of women reporting consuming any alcohol during this period.

In contrast to previous research reporting that most women who drink tend to consume only low quantities of alcohol during pregnancy (Colvin et al., 2007; Ethen et al., 2009; Giglia and Binns, 2007; Kesmodel et al., 2003; Mullally et al., 2011), women in this cohort were more likely to drink at binge or heavy rather than low or moderate levels in this early period. This pattern is consistent with alcohol use among women of childbearing age, who are not necessarily pregnant (Caetano et al., 2006). Patterns of alcohol use post-pregnancy awareness were similar to patterns reported in previous studies, yet alcohol use prior to pregnancy awareness was markedly higher. The hypothesis that the period between conception and pregnancy recognition represents a distinct time point in pregnancy, at high risk of alcohol exposure, has been supported.

The pattern of demographics associated with alcohol use in this study was consistent with predictors of alcohol use in pregnancy reported in previous epidemiological studies, and describe a population of relatively socially advantaged women. SES was the strongest predictor of alcohol use in this period, with drinkers tending to be of higher SES than abstainers. Drinkers also had overall higher educational attainment than abstainers, were more likely to be smokers, more likely to be of English-speaking background, and were more likely to be in their first pregnancy. Women who drank alcohol in this time period were less likely to have actively planned their pregnancies than abstainers. BMI, marital status, and illicit substance use were not significant predictors of alcohol consumption after statistical adjustment for other maternal characteristics. A sensitivity analysis found that women who drank at binge or heavy levels followed the same pattern of maternal characteristics as drinkers overall compared with abstainers, yet were additionally found to be older than abstainers.

This pattern of maternal characteristics is in contrast to factors found to be associated with FASD, which is concentrated in socially disadvantaged populations (Abel, 1995), as well as geographical and maternal characteristics of pregnant women with documented alcohol abuse history (Burns et al., 2011). Even when women in this sample who drank at binge or heavy levels were examined separately, they were found to be no different in terms of SES or educational attainment, to low or moderate drinkers. It is possible that the sample recruited for this study is of particularly high social advantage and that women of relative social disadvantage are underrepresented. It could also be the case that women of lower social advantage who are included were systematically underreporting their alcohol use. Alternatively, women with children diagnosed with FASD described in previous literature could be a unique population that is not captured here.

Most women completely stopped drinking alcohol once becoming aware of their pregnancy. Only a small percentage continued drinking at the same level, and most of these women who continued drinking were only consuming low levels of alcohol use prior to pregnancy awareness. Women who drank at binge or heavy levels prior to pregnancy awareness were more likely to cease drinking completely than they were to either reduce or continue drinking during the time between conception and recognition of pregnancy. The sensitivity analysis showed that women in this group were more likely to have unplanned pregnancies, and this may be one explanation for this finding.

This study identified factors associated with changes to women's alcohol use following the point of pregnancy recognition. These included level of alcohol use prior to pregnancy recognition, maternal age, pregnancy planning, and illicit substance use. Heavy drinkers were more likely to cease drinking than low or moderate drinkers were. Women drinking at low or moderate levels were more likely to continue drinking at the same level than they were to cease completely relative to heavy drinkers. The youngest women in the sample were more likely to completely cease drinking following pregnancy awareness rather than to simply reduce consumption, compared with the oldest women. Women who continued drinking following pregnancy recognition were more likely to have unplanned pregnancies and were more likely to have used illicit substances in pregnancy, relative to those who ceased drinking.

These findings are in line with a recent study using routinely collected data in a large Australian sample, which showed that women tend to moderate alcohol use in pregnancy compared with their prepregnancy consumption (Kingsbury et al., 2015). However, the present findings directly oppose recently published data from an Australian prospective cohort study, which reported that women who were binge drinkers prior to pregnancy were unlikely to change drinking patterns when pregnant (with alcohol use also assessed via maternal self-report) (Anderson et al., 2014). Notable differences between the present sample and that used in Anderson and colleagues (2014) are the recruitment method, with Anderson and colleagues using random sampling from Medicare records; and geographical location, with the present study being based in metropolitan areas, while Anderson and colleagues (2014) specifically oversampled women from rural and remote areas. With such disparate findings between these 2 studies, it is clear that this is an area in need of further research to clarify differences that may be due to alcohol use, as opposed to those that could be due to demographic factors; and that it would not be appropriate to generalize results of either study to the Australian population as a whole. However, while it is not possible to make direct comparisons, findings of these 2 studies taken together suggest that trajectories of alcohol use following recognition of pregnancy may differ systematically depending on geographical location and, implicitly, SES of women.

Limitations

While alcohol use data were obtained via self-report, this occurred during pregnancy at multiple time points, so recall bias is unlikely to have affected reporting. In a study investigating maternal recall of alcohol use, reports of alcohol use

obtained during pregnancy were found to be more valid than retrospective reports obtained after pregnancy (Jacobson et al., 2002). Nevertheless, self-reported alcohol consumption is still thought to be frequently under estimated (Lange et al., 2014). The most obvious driving factor for this tendency is the stigma associated with alcohol consumption during pregnancy. While there is a strong argument for educating the public about the risks associated with alcohol consumption during pregnancy, one of the unintended side effects of the subsequent increased awareness and lowered social tolerance of alcohol use during pregnancy is shame among women who have consumed alcohol during pregnancy (Bell et al., 2016; Jones and Telenta, 2012; Racine et al., 2015). This may lead to reluctance to disclose drinking to their doctors for fear of being blamed for poor outcomes of their children, or having their child removed from their custody in more extreme cases (Bell et al., 2015). Therefore, while the prevalence of alcohol use reported was high in this sample, it could still be a conservative estimate.

With regard to pregnancy planning, it should be noted that among those answering "I wanted to become pregnant," this question could potentially have captured some women with mistimed pregnancies; that is, they wanted to be pregnant in the future but not necessarily at the time they actually fell pregnant. Some possible inconsistency regarding pregnancy wantedness and contraceptive use was noted. Socially biased responding may also have influenced responses to this question, particularly as it was asked after awareness of pregnancy, and that all women planned to be primary caregiver for their child.

This sample was recruited from metropolitan hospitals, so women from rural and remote areas are not represented in this study. Women of lower SES are also under represented. Existing literature suggests that these groups of women may be at particular risk of having alcohol-exposed pregnancies (Burns et al., 2011; Peadon et al., 2010), so future studies specifically recruiting women from these communities would be informative.

CONCLUSIONS

This study has found that most women cease or reduce alcohol consumption after confirming pregnancy. However, fetal alcohol exposure was highly prevalent, exceeding previous estimates of the rate of alcohol-exposed pregnancies, when the period prior to pregnancy recognition was taken into account, even among women who had planned their pregnancies. This suggests that public health strategies addressing alcohol use prior to pregnancy recognition may be more effective in reducing the risk of alcohol-exposed pregnancies in the general population than messages providing information about possible risks associated with continued drinking into pregnancy. However, future research involving under represented low SES, rural, and indigenous populations would be informative.

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CONFLICT OF INTERESTS

None to declare.

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